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STATISTICAL DATA AND THE HISTORY OF WOMEN: A CRITIQUE OF MARGARET ROSSITER'S WOMEN SCIENTISTS IN AMERICA: STRUGGLES AND STRATEGIES TO 1940

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ABSTRACT

Rossiter's book, based on a wide variety of sources, including numerous manuscript collections, is a goldmine of information. At its core is a statistical data base drawn from successive editions of American Men of Science. The book adds in a major way to our knowledge of its central subject. It also opens a window onto several little explored topics in the history of American science. However, Rossiter makes no standard tests of the significance of her valuable statistics. More important, she commits the major methodological sin of giving inadequate attention to alternative explanations of the numerical data. The result is that while Rossiter amply documents the considerable discrimination that women faced in the American scientific enterprise, she leaves cloudy the relative force of that discrimination compared to internalized cultural norms, marital and maternal obligations, and the like.

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WOMEN SCIENTISTS IN AMERICA: STRUGGLES AND STRATEGIES TO 1940

In the United States, Margaret Rossiter observes, most women scientists at work through 1940 "bordered on the `invisible.'" Save for the appreciation of a few of their contemporary colleagues, they worked unnoticed under difficult professional handicaps and what they managed to achieve went generally unrecognized and unrewarded. For the most part, they have remained invisible to history. Some years ago, Rossiter began a long, arduous, and painstaking scholarly effort to rescue these scientists from obscurity and to analyze why in their own era they were so hidden from view. The result is Women Scientists in America, a book rich in information, forceful in argument, and provocative, though often rather singleminded, in interpretation.[1]

To bring her subjects to light, Rossiter mined a breathtakingly large and diverse array of published and unpublished primary and secondary sources, including numerous manuscript collections, directories, and bibliographies. But at the core of this book lies a statistical data base drawn primarily from American Men of Science (AMS), which despite its title listed females as well as males, from the first edition of 1906 through its five successors to 1938. Rossiter combed this main directory for every woman in it, assiduously tracking each one through changes of job and name. As she readily acknowledges, the AMS is imperfect; it omits in particular

probably the majority of scientists in industry and government. Nevertheless, in the absence of any alternative, Rossiter has constructed from these directories about as complete an inventory of women scientists in America for the period to 1940 as we are ever likely to have. She has identified their educational backgrounds, graduate training or lack of it, scientific fields, career trajectories, and, where possible, marital status. She has also summarized this data in tabular statistical form. To have done all this for a population that by 1938 came to some 1,900 women is a stunning achievement in data gathering and presentation for which historians and sociologists of science will long be in her debt.

To summarize the main outlines of Rossiter's story, in the later nineteenth century the creation of the women's colleges provided regular scientific training and for some women an important place of employment. The period from 1880 to 1910 was marked by both the opening and the limitation of opportunity to women in the emerging structure of professional science. It was then that women infiltrated and finally won formal admission to American graduate schools, including the right to earn advanced degrees, and that they managed to obtain faculty appointments at coeducational colleges and universities. Post-1910, the number of women, like the number of men, in American science grew enormously. From World War I to 1940, the period to which Rossiter devotes half her book, women also entered industry and government science. Nevertheless, though some achieved national prominence, full professorships, and such honors as election to the National Academy of Sciences, by 1940, Rossiter concludes,

women were as marginal in the scientific enterprise, and their chances for recognition as limited, as they had been in 1920.

Rossiter stimulates fresh thought about the history of science by subjecting the question of how this pattern came into being to the conceptual approach of labor-market analysis. She argues that between 1880 and 1910 there developed a separate labor market for women in science, arising from the new supply of trained personnel from the women's colleges, discrimination against women in many sectors of the main scientific labor force, and the growing bureaucratization of scientific research. Among the salients of big, bureaucratic science was the Harvard Observatory of Edward C. Pickering, whose research program in astrophysics required much assistance in the detailed task of analyzing photographic plates of stellar spectra and who found the assistants relatively cheaply in the 20 women he hired between 1885 and 1900.

In the late nineteenth century, many women were classed as amateur scientists when the scientific societies of the day started to upgrade themselves into professional groups by excluding or reducing amateur participation. Rossiter points out that the process of professionalization consequently resulted in a "drastic defeminization of the higher ranks of those branches of science that women were then entering in appreciable numbers: natural history, anthropology, botany, and marine biology. Even this was only the most noticeable part of the phenomenon, for in most other scientific fields participation in a `professional' society presupposed visible employment in the field, a criterion that, because of prevailing

practices, excluded all but the women professors from membership. . . . `Prestige´ and `professionalism´ were thus concepts that would within a few decades reshape `science´ to make it seem even more masculine than it really was."(p.73)

To analyze more generally why women scientists were hidden and to such a degree confined to a secondary labor market, Rossiter deploys the analytic categories of "hierarchical" and "territorial" discrimination. By hierarchical discrimination, she means the refusal of the male-dominated scientific system to award women the institutional rank and opportunity, the professional mobility and recognition that their talents and achievements would have merited in a truly open meritocratic system. By territorial discrimination, she means the comparative exclusion of women from certain fields -- engineering, for example -- and their general confinement to "woman´s work" -- fields such as home economics, which were assumed to be appropriate for women, or activities within other fields, like the detailed scrutiny of stellar spectra plates, for which women were said to possess special talents. Rossiter presents solid statistical data that women did in fact tend to be concentrated in certain disciplines, e.g., psychology, zoology, and botany; that they slowly entered others, e.g., biochemistry and statistics; and that they remained a tiny percentage in some, e.g., physics.

Rossiter provides ample evidence that in academia, government, and industry, women were disproportionately in subordinate positions, paid less and allowed fewer opportunities than men, and often denied appropriate recognition for their achievements, including, except for

the women's colleges, senior academic appointments. In the early 1920s, women's groups managed to obtain reform of the civil service rules in the interest of equal employment opportunities and equal pay, but agency heads could -- and did -- slip through loopholes in the revised regulations, which permitted them to specify whether or not a woman was acceptable for a given post or to downgrade the classification of jobs that women tended to hold. On the territorial side, early in the century Edward C. Titchener, one of the leading American pioneers in experimental psychology, refused to let women participate in his professionally important Society of Experimental Psychologists. In 1934, Robert A. Millikan, the Nobel laureate and head of the California Institute of Technology, advised President W.P. Few of Duke University against the appointment of Hertha Sponer, a thoroughly able scientist, to a professorship of physics. Few women did well in physics, Millikan argued. The future in the discipline in the United States rested with the "bright young men."(p.26)

If women did not compare well with men in physics or other fields, Rossiter contends, it was because they were circumscribed by a "logic of containment," the rationalization of territorial and hierarchical practice. She adds that "although most of the barriers to women's advancement that one finds documented are administrative or procedural, at root they were cognitive and perceptual." (p.167) Amid the relegation of women scientists to low-status, marginal positions, the academic world's low expectations of them formed a self-fulfilling prophecy. Women faculty, generally condemned indefinitely to subordinate positions, understandably tended to fall into a pattern of

subservient behavior and low productivity.

Though supported by relatively little direct evidence, Rossiter's view that discrimination reacted deleteriously back upon the attitudes and productivity of the women forced to suffer it is compelling for its plausibility and human perceptiveness. Unfortunately, Rossiter brings to other facets of her subject less discernment than one would think necessary. She lumps women together with Catholics, blacks, and Jews as equally the victims of discrimination by the American academic elite, even though each of these groups had sets of attitudes and aspirations with regard to scientific careers quite different from those of women, and from each other. She commits a few important factual errors, among them the declaration that Robert M. Yerkes had no experience prior to World War I in mental testing -- he was in fact known for the Yerkes point scale -- and that, as a result, he was unqualified to head the U.S. Army's wartime testing program. More important, a number of Rossiter's interpretive assessments, minor and major, seem to lack appropriate balance of judgment.

One can hardly accept as anything more than bizarre Rossiter's speculation -- if I correctly understand her implication -- that Alfred Nobel may have created his prizes for fields with few women -- "the most . . . `macho' fields of science"(p.294) -- rather than with many, so as, if only unconsciously, to minimize recognition of their scientific accomplishments; or as anything more than gratuitous suspicion that men who did hire many women were likely motivated by the pleasure of surrounding themselves with a harem or by some

insecurity at the prospect of having too many able male subordinates. Rossiter tacitly presumes to see more clearly than most into the motives hidden in the human mind and heart. But she seems to have approached her subject with tunnel vision, with a singleminded tendency to perceive virtually every setback suffered by women scientists in America as the result of sexually discriminatory intent.

Rossiter notes that there is little evidence bearing directly on intent as patent as Millikan's blithely stated prejudice or Titchener's infuriatingly mulish misogyny. In its absence, much of her analysis rests on inference of intent from circumstance and behavior, especially the behavior measurable by statistics. Fair enough, but in such a task, caution would seem imperative. So would a readiness to consider alternative explanatory hypotheses. A major difficulty with this book is that on key issues, including the central matters of hierarchical and territorial discrimination, neither caution nor the consideration of alternatives appears to be sufficiently present.

In assessing the fate of women scientists in America, Rossiter has looked mainly in one direction, neither sideways nor downward but up. She has tended to measure the welfare of women scientists in America against that fraction of scientists, almost entirely male to be sure, who were in favored positions at major research universities, leading industrial laboratories, and the better developed scientific agencies of the federal government. But the large majority of scientists in America did not hold such positions. Many male scientists were employed in academic posts with limited or no research

opportunities; in industrial laboratories where, despite their companies' rhetorical celebration of pure science, they were compelled to follow a strictly practical kind of research that often amounted to mere product testing; and in governmental agencies where, for the most part, they were confined to routine work. This large majority of scientists in the United States, males included, have tended to be hidden, like women, from their contemporaries as well as history, and, judged by this book, from Rossiter's sensibility.

By virtually assuming that all males were favored, Rossiter probably distorts the degree to which women were not. She argues that at the turn of the century, postdoctoral fellowships were usually denied to women; that in industry women were channeled into deadend jobs; that female coworkers in research often did not receive recognition. All these claims are true enough, but without male comparisons they are misleading in the degree of sexual discrimination they reveal. Precisely by making that comparison, Rossiter proves the case that sexual discrimination operated in the award of National Research Council Fellowships after World War I, when the era of plentiful postdocs began. But she neglects to consider that at the turn of the century the number of such fellowships available to everyone was miniscule; that many, perhaps most, men in industrial science wound up in deadend jobs; that due credit was often not given to male research coworkers. This is not to say that for the sake of a comparative benchmark, Rossiter should have written the history of male as well as of female invisibles. It is to say that the bureaucratization of science, like the bureaucratization of most work

in the modern world, relegated numerous men as well as women to subordinate, not infrequently frustrating roles, and that this book would have profited from a broadening of vision concerning such matters.

Attentive to the importance of comparing women with men statistically, Rossiter wisely constructed a sample of males drawn from the 1921 and 1938 editions of American Men of Science, and she used such additional statistical information as the doctoral fellowship data published by the National Research Council. She notes that 11.9% of American university science doctorates between the wars went to women, but that women accounted for only 7% of the people in the 1938 AMS. She concludes that many of the women who earned doctorates must not have made it into the directory, while many men, even those without U.S. doctorates, did. Unless I utterly misread Rossiter, I am unable to make sense out of this conclusion. It unreasonably compares percentage of doctorates with percentage of all scientists, including those without the Ph.D. And it assumes that the percentage of women who took doctorates between 1921 and 1937 should equal the percentage of women among all scientists in the 1938 AMS, which lists many who entered science before 1921.

Unfortunately, nowhere in this book, which hangs great interpretive weight on statistical data, is there a test of statistical significance. Such tests, which suggest whether statistical differences between, say, men and women, result from chance or not, ought to be performed as a matter of course. Patterns produced by chance do not usually contain historical or sociological

meaning. And patterns produced by something other than chance do not necessarily reveal intent.

To Rossiter, the downgrading of women during the late-nineteenth century professionalization of science was not merely a secondary consequence of the drive to diminish the role of amateurs. According to her account, "An influx of women who rarely held important positions in science, if any at all, usually was seen in these years as a threat to a group's precarious `prestige' and triggered an intense discussion of the need to `raise standards' for membership. Since the concepts of prestige, status, and professionalism were at the time closely intertwined with that of masculinity, the new membership requirements that were introduced in the 1870s through the 1890s were often deliberately [emphasis added] harder on women than on men." (p.23)

Rossiter provides no definition of what she takes the vague terms "prestige," "status," and "masculinity" to mean, and she offers no direct evidence for how they were entwined with the concept of professionalism. Although she is imprecise as to what degree the drive for professionalism was linked to the aim of excluding women, she appears to believe it was strong. She rightly stresses that men often excluded women from the post-meeting dinners and smokers of scientific societies, yet such spotlighting of social convention does not necessarily illuminate the dominant tendency of the period in the organization of learning. The drive to professionalize American science was intimately connected with the presumably defensible aim of raising its quality, and the drive was manifest in virtually all

disciplines, including those like physics in which there were hardly any women. Besides, professionalization plainly excluded male as well as female amateurs. Objections could be raised to Rossiter's treatment of the professional organization of geology, chemistry, and psychology, but for the sake of brevity, illustration of the problem will have to be confined to her discussion of the creation of a second-tier membership category of "fellow" -- for people professionally engaged in science or aiding it -- in the American Association for the Advancement of Science.

The category was created in the 1870s, "for reasons that were unspecified," Rossiter says darkly, following a steady influx of women that "may have worried the leaders." Rossiter adds that the category of fellows resulted in "a sexual division of membership levels."(p.76) While four to eight women annually joined the AAAS through the 1870s, and still more did so in the 1880s, only seven became fellows during the first decade of the fellowship honor. When the category of fellows was established, the fraction of women in the AAAS came to 6.8%, which one would think would hardly worry the typical male chauvinist. In any case, Rossiter supplies no other evidence whatsoever that the influx of women figured at all in the creation of the new membership category. More important, she ignores essential contextual points -- the fact that the question of professionals versus amateurs had vexed the AAAS for many years prior to the 1870s, that the issue had been given renewed immediacy after the Civil War by the creation of the National Academy of Sciences, and that the impulse to professionalization struck at amateurs of both sexes. With regard

to interpreting the consequences of the membership distinction, one would think that she should at the least have compared the percentage of new female members elected to fellowship status in the same period with the percentage of new males similarly favored.

It is a major contention of Rossiter's that women had to meet a higher standard than did men to make it in American science. Many women thought they did, and perhaps they were right, not least because of what Rossiter suggests was the Madame Curie standard. When Marie Curie visited the United States in 1921, women celebrated her as proof that their sex possessed the same capabilities in science as men, and that any American woman could well follow in her footsteps. But according to Rossiter, "before long most professors and department chairmen were interpreting Curie's example far more restrictively and expecting that every female aspirant for a faculty position must be a budding Marie Curie. They routinely compared American women scientists of all ages to Curie and, finding them wanting, justified not hiring them on the unreasonable grounds that they were not as good as she, twice a Nobel laureate!" (p.127)

One looks in vain in this book for much direct evidence beyond Millikan and Titchener that powerful male academics did this routinely. Rossiter does offer statistical evidence for a "double standard that required" (p.133) women to be better qualified than men. She offers up the same evidence in support of the quite plausible claim that women scientists of the interwar era internalized and pursued a "Madame Curie strategy," believing it necessary to meet the Madame Curie standard and deliberately overqualifying themselves to

try to do so. The evidence is drawn from her data concerning the men and women in the 1921 and 1938 editions of the AMS. Rossiter finds that for the scientists listed in both editions, the percentage of women holding doctorates exceeded the percentage of men with Ph.D.s by about 13 points. Though she did not test this result for statistical significance, a chi-squared calculation reveals that the difference is statistically significant at a high level of confidence. The question is whether the difference uniquely supports the interpretive construction of a double standard.

To take a brief excursion through the raw data, of the 1,912 women listed in the 1938 edition of the AMS, 1,591, or 83.2%, held doctorates. If 351 more women without doctorates had been listed in the 1938 edition, the percentage of women with doctorates would have been the same, 70.3%, as the percentage of Ph.D. men. This is to say that in the seventeen years between the two editions, the sexual disparity in Ph.D. statistics could have resulted from an average dropout rate of only 20 to 21 non-Ph.D. women scientists per year. One suspects that this would not have been a large number measured against, say, the total annual number of female first-degree graduates in science. What is troubling here is that Rossiter takes the disparity as unequivocal evidence of a double standard, either internalized, imposed, or both. But the data could just as plausibly be explained in terms of dropouts, especially since the dropouts would have been women without the investment in a Ph.D. Of course, women scientists may have dropped out because of the sexual barriers they faced. But they may also have dropped out because they married, had

families, and, like women who might have stayed in countless other fields, permanently left the work force. Doubtless both factors came into play, the one internal to the scientific system, the other inherent in the cultural standards that did so much to shape the self-expectations of women as well as their behavior.

A similar objection could be raised to Rossiter's view that anti-nepotism rules counted strongly for the high proportion of married women she has found among unemployed female scientists in the 1930s. Another way of reading the data is that married women, not expected under the cultural norms of the day to be the principal family providers, could remain in science even though they earned no income. In contrast, married men who could not get jobs would have been more likely to leave science for occupations -- school teaching, for example -- where they could find employment. This latter explanation, at least a supplement if not an alternative to the force of nepotism, is consistent with what little general evidence we have about scientific employment during the depression, and it is also suggested by the incredibly low unemployment rate, 1.3%, of male scientists in the 1938 AMS.

Surely the self-expectations and behavior of women scientists derived in some part from their internalization of the roles assigned to them by the general socio-cultural environment. This book is peculiarly purblind in its lack of attention to the conflicts that many women scientists may have felt between the internalized sense of duty to, say, marriage and motherhood on the one side and the requirements of a life in professional science on the other. The

earlier generation of women scientists seems to have dealt with the problem mainly by remaining unmarried, a course in which they were often forcibly aided by the refusal of even womens' colleges to permit married women on the faculty. Rossiter shows that many of the later generation married, but she neglects even to raise a matter, if only in an unsystematic way that the fragmentary data may require, that must have been of some importance in many of their lives -- whether they had children, and, if they did, how they reconciled the demands of family and career.

One also misses in this book a clearcut assessment of the role that the socio-cultural environment played in the types of science that women tended to enter. Territorial discrimination undoubtedly helped keep them from certain fields, but women may also have self-selected themselves out of, say, physics and into, say, psychology, because physics was identified with abstract questions concerning inanimate matter while psychology, especially educational, developmental, and clinical psychology, the fields in which women tended to cluster, involved children, nurturing, and human contact. Rossiter recognizes the sexual stereotyping of particular fields. What she leaves cloudy is the degree to which women themselves internalized the stereotypes and entered one discipline rather than another not only by the channeling of male professors but also by virtue of choice, perhaps made under false consciousness but, especially if made in the womens' college environment, choice nonetheless.

There is a central methodological issue in all this. The

point here is not to depreciate the force of sexual discrimination in shaping the lives of women scientists but to insist that some assessment must be made of the relative weight of that force against others separable from, though possibly related to, it. For this reason it is imperative to consider that statistical data may be ambiguous and to entertain as well as weigh alternative or supplementary interpretations. There is too little space here to suggest how this might be done, but it can, using the kind of data that Rossiter has accumulated with such admirable tenacity. One hopes that she will do so in her future work in the subject. In this book, having so far as one can tell little considered, entertained, or weighed alternatives, Rossiter might well have advanced her conclusions with rather more tentativeness and caution.

Despite its methodological flaws and undue interpretive certainty, this is an important and valuable book. Its 79 pages of closely printed footnotes are a goldmine of information, incident, primary as well as secondary sources, and observations and insights, ranging, as is Rossiter's wont, from the tart to the sympathetic. Rossiter opens our eyes not only to the tangled overall history of her main subject but, among many topics, also to the history of fields long heavily occupied by women, notably the evolution of home economics into nutrition; to the significant number of women who came to scientific prominence through partnerships that combined marriage and research; to the critical importance of women's colleges in establishing the female sector of the scientific community. Rossiter also helps open further to historical view the worlds of industrial

and government science, the latter not only at the federal but at the state and local levels. If this book is something of an object lesson in the perils of statistical history, so is it a striking example of how much can be learned from numerical data used in conjunction with traditional sources. Above all, it spotlights the central importance for the social history of science of making visible all of the traditionally invisibles -- the men as well as women who have constituted the vast majority of the American scientific community.

1. Margaret W. Rossiter. Women Scientists in America: Struggles and Strategies to 1940 (Baltimore/London: The Johns Hopkins University Press, 1982)